Introduction and Classification of Waves DPP-01

1. When a sound wave goes from one medium to another, the quantity that remains unchanged is

(1) Frequency
(2) Amplitude
(3) Wavelength
(4) Speed

2. Transverse waves can propagate in

(1) Liquids
(2) Solids
(3) Gases
(4) All

3. The type of waves that can be propagated through solid is

(1) Transverse
(2) Longitudinal
(3) Both (1) and (2)
(4) None of these

4. Which of the following do not require medium for propagation

(1) Mechanical wave
(2) Electromagnetic wave
(3) Sound wave
(4) None of the above

5. Mechanical waves on the surface of a liquid are

(1) Transverse
(2) Longitudinal
(3) Torsional
(4) Both transverse and longitudinal

6. Sound wave transfer

(1) Only energy not momentum
(2) Energy
(3) Momentum
(4) Both (2) and (3)

7. Which of the following is the example of transverse wave

(1) Sound waves
(2) Compressional waves in a spring
(3) Vibration of string
(4) All of these

8. If the speed of a wave doubles as it passes from shallow water to deeper water, its wavelength will be

(1) Unchanged
(2) Halved
(3) Doubled
(4) Quadrupled

9. The number of waves contained in unit length of the medium is called

(1) Elastic wave
(2) Wave number
(3) Wave pulse
(4) Electromagnetic wave

10. If Angular wave number is 8 π rad/m, then wavelength and angular frequency respectively. If velocity of wave 300 m/s.

(1) 0.25 m, 2400 π rad/sec,
(2) 0.25 m, 1200 π rad/s
(3) 0.20 m, 1000 rad/sec
(4) 0.24 m, 2400 rad/sec

11. If wavelength of wave $\lambda = 20\text{m}$ and its frequency 200 Hz. Its velocity becomes

(1) 2000 m/s
(2) 4100 m/s
(3) 4000 m/s
(4) 4200 m/s

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11
Answer	1	4	3	2	4	4	3	3	2	2	3

SOLUTIONS

1. **(1)**
Frequency of wave is a function of the source of waves. Therefore, it remains unchanged.

2. **(4)**
Transverse wave can propagate in solids, liquids and gases.

3. **(3)**
Since solid has both the properties (rigidly and elasticity)

4. **(2)**
EM waves do not require medium for their propagation

5. **(4)**
The mechanical wave on the surface of the liquid are both the transverse as well as longitudinal waves.

6. **(4)**
Sound wave transfers both energy and momentum.

7. **(3)**
Example of transverse waves include vibration on a string.

8. **(3)**
Since frequency remains unchanged,
$f = f'$
$\frac{v}{\lambda} = \frac{v'}{\lambda'}$
$\frac{v}{\lambda} = \frac{2v}{\lambda'}$
$\lambda' = \frac{2v}{v}\lambda$
$\lambda' = 2\lambda$
Hence, its wavelength will become twice

9. **(2)**
Wave number is the reciprocal of wavelength and is written as $\bar{v} = \frac{1}{\lambda}$

10. **(2)**
Given angular wave number
$k = 8\pi \frac{rad}{m}$

We know that, $k = \frac{2\pi}{\lambda}$

$8\pi = \frac{2\pi}{\lambda}$

$\lambda = \frac{2}{8}$

$\lambda = 0.25m$

now $n = \frac{v}{\lambda} = \frac{300}{0.25} = 1200\ Hz$

$\omega = 2\pi n = 1200 \times 2\pi = 2400\ \pi\ rad/sec$

11. **(3)**

Relation between velocity and wavelength

$v = f\lambda$

$v = (20)(200)$

v = 4000 m/s.

Wave Equation and Characteristics of Waves DPP-02

1. The wave described by $y = 0.25\sin(10\pi x - 2\pi t)$ where x and y are in meters and t in seconds, is a wave travelling along the

(1) Positive x direction with frequency 1 Hz and wavelength λ = 0.2 m

(2) Negative x direction with amplitude 0.25 m and wavelength λ = 0.2 m

(3) Negative x direction with frequency 1 Hz

(4) Positive x direction with frequency π Hz and wavelength λ = 0.2 m

2. If the equation of transverse wave is $y = 5\sin 2\pi\left[\frac{t}{0.04} - \frac{x}{40}\right]$, where distance is in cm and time in second, then the wavelength of the wave is

(1) 60 cm
(2) 40 cm
(3) 35 cm
(4) 25 cm

3. The equation $y = A\cos^2\left[2\pi nt - 2\pi\frac{x}{\lambda}\right]$ represents a wave with

(1) Amplitude $\frac{A}{2}$, frequency 2n and wavelength $\frac{\lambda}{2}$

(2) Amplitude $\frac{A}{2}$, frequency 2n and wavelength λ

(3) Amplitude A, frequency 2n and wavelength 2λ

(4) Amplitude A, frequency n and wavelength λ

4. A transverse wave is represented by $y = A\sin(\omega t - kx)$, for what value of the wavelength is the wave velocity equal to the maximum particle velocity

(1) A

(2) $\frac{\pi A}{2}$

(3) πA

(4) $2\pi A$

5. The equation of a progressive wave can be given by $y = 15\sin(660\pi t - 0.02\pi x)$ cm. The frequency of the wave is

(1) 330 Hz
(2) 342 Hz
(3) 356 Hz
(4) 660 Hz

6. The instantaneous displacement of a simple harmonic oscillator is given by, y = $a\cos\left[\omega t + \frac{\pi}{4}\right]$. Its speed will be maximum at the time

(1) $\frac{2\pi}{\omega}$

(2) $\frac{\omega}{2\pi}$

(3) $\frac{\omega}{\pi}$

(4) $\frac{\pi}{4\omega}$

7. The displacement x (in meter) of a particle performing simple harmonic motion is related to time t (in second) as $x = 0.05\cos\left(4\pi t + \frac{\pi}{4}\right)$. The frequency of the motion will be

(1) 5 Hz

(2) 1.0 Hz

(3) 1.5 Hz

(4) 2.0 Hz

8. The frequency of the sinusoidal wave $y = 0.40\cos[2000t + 0.80x]$ would be

(1) 1000π Hz

(2) 2000 Hz

(3) 20 Hz

(4) $\frac{1000}{\pi}$ Hz

9. A progressive wave of frequency 500 Hz is travelling with a velocity of 300 m/s. How far apart are two point having phase difference of 60°?

(1) 0.10 m

(2) 0.12 m

(3) 0.14 m

(4) 0.20 m

10. If time difference of two waves is 5 sec. & frequency are 50 Hz find out its path difference (given λ = 5 m)

(1) 1250 m

(2) 1230 m

(3) 1240 m

(4) 1210 m

11. Which of the following equation can represent wave equation?

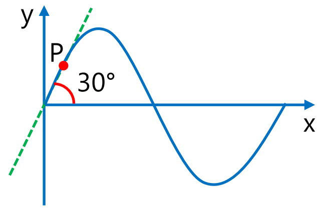
(1) $y = A\sin(\omega t^2 - kx)$

(2) $y = A\tan(\omega t - kx)$

(3) $y = A\cos(\omega t - kx)$

(4) $y = \frac{1}{t-x}$

12. If the given wave moves along +x direction with speed of 330 m/s. Find out velocity of particle p.



(1) $-110\sqrt{3}$ m/s (Downward)

(2) $-110\sqrt{3}$ m/s (Upward)

(3) $-115\sqrt{3}$ m/s (Downward)

(4) $-115\sqrt{3}$ m/s (Upward)

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12
Answer	1	2	1	4	1	4	4	4	1	1	3	1

SOLUTIONS

1. **(1)**

Comparing with standard equation we get

$\frac{2\pi}{\lambda} = 10\pi$

$\therefore \lambda = \frac{2\pi}{10\pi} = 0.2\text{m}$

$\omega = 2\pi$

$\therefore n = 1$ Hz

And the wave is travelling along the positive direction.

2. **(2)**

Comparing with $y = a\sin 2\pi\left[\frac{t}{T} - \frac{x}{\lambda}\right] \Rightarrow \lambda = 40 \text{ cm}$

3. **(1)**

The given equation can be written as

$y = \frac{A}{2}\cos\left(4\pi nt - \frac{4\pi x}{\lambda}\right) + \frac{A}{2}\left[\because \cos^2\theta = \frac{1+\cos 2\theta}{2}\right]$

Hence amplitude $= \frac{A}{2}$ and frequency $= \frac{\omega}{2\pi} = \frac{4\pi n}{2\pi} = 2n$

And wave length $= \frac{2\pi}{k} = \frac{2\pi}{\frac{4\pi}{\lambda}} = \frac{\lambda}{2}$.

4. **(4)**

Wave velocity $\Rightarrow v_\omega = v_{pmax}$

$n\lambda = \omega A$

$n\lambda = 2\pi nA$

$\lambda = 2\pi A$

5. **(1)**

Given that

$y = 15\sin(660\pi t - 0.02\pi x)$

Comparing with general equation of progressive wave, we get

$y = (x, t) = a\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$

$\therefore \frac{2\pi}{T} = 660\pi$ or $\frac{1}{T} = 330$ or $\bar{v} = 330$ Hz

6. **(4)**

$y = a\cos\left(\omega t + \frac{\pi}{4}\right)$

$v = \frac{dy}{dt} = -a\omega\sin\left(\omega t + \frac{\pi}{4}\right)$

Speed is maximum when $\left(\omega t + \frac{\pi}{4}\right) = \frac{\pi}{2}$

$\omega t = \frac{\pi}{2}$

$t = \frac{\pi}{4\omega}$

7. **(4)**

Compare the given equation with the standard form

$y = A\cos\left[\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right]$

Coefficient of $t = \frac{2\pi}{T} = 2\pi n = 4\pi, n = 2\ \text{Hz}$

8. **(4)**

Compare the given equation with $y = a\cos(\omega t + k\phi)$

$\Rightarrow \omega = 2\pi n = 2000 \Rightarrow n = \frac{1000}{\pi}\ \text{Hz}$

9. **(1)**

We know that for a wave

$v = f\lambda$

$\lambda = \frac{v}{f}, \lambda = \frac{300}{500} = \frac{3}{5} = 0.6\ \text{m}$

Phase difference $\Delta\phi = 60° \Rightarrow \left(\frac{\pi}{180°}\right)(60°)$

$\Rightarrow \frac{\pi}{3}$ rad.

Path difference $\Delta\lambda = \left(\frac{\lambda}{2\pi}\right)(\Delta\phi)$

$= \frac{0.6}{2\pi}\left(\frac{\pi}{3}\right) = 0.1\ \text{m}$

10. **(1)**

$\Delta x = \left(\frac{\lambda}{T}\right)\Delta t \ \left\{\frac{1}{T} = f\right\}$

$\Delta x = \left(\frac{5}{T}\right)\Delta t$

$\Delta x = 5 \times 5 \times 50$

$\Delta x = 1250\ \text{m}$

11. **(3)**

12. **(1)**

$v = 330\ \text{m/s}$

$\tan\theta = \tan 30° = \frac{1}{\sqrt{3}}$

$v_p = -330 \times \frac{1}{\sqrt{3}} = -110\sqrt{3}$ m/s (Downward)

Energy and Intensity of Waves DPP-03

1. If power of transverse wave is 512 watt, find the energy of wave after t = 4 sec.?

(1) 4800J
(2) 2052J
(3) 2048J
(4) 4802J

2. Formula of energy of progressive wave in one wavelength is,

(1) $\frac{1}{2}\mu A^2\omega^2\lambda$
(2) $\frac{1}{2}\frac{\mu A^2\omega^2}{\lambda}$
(3) $\frac{1}{2}\mu A^2\omega^2\lambda^2$
(4) $\frac{1}{2}\frac{\mu A^2\omega^2}{\lambda^2}$

3. The total energy of wave with the values, $A = 10$ meters, $\omega = 1$Hz, $\lambda = 1$m, $\mu = 1$ Kg/m.

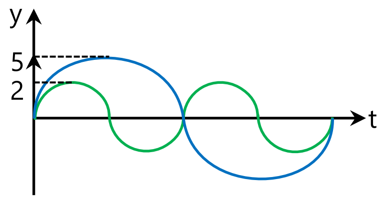
(1) 50J
(2) 500J
(3) 0.5J
(4) 10J

4. A wave has value $A = 100$m, ω = 3Hz, μ = 7kg/m and total energy = 1.26MJ. What is the value of λ.

(1) $\lambda = 5$
(2) $\lambda = 4$
(3) $\lambda = 9$
(4) $\lambda = 16$

5. Two waves in the same medium are represented by y-t curves in the figure. Find the ratio of their intensities?

(1) $\frac{25}{16}$
(2) $\frac{16}{52}$
(3) $\frac{4}{5}$
(4) $\frac{5}{4}$



6. If amplitudes of two waves are 2m and 5m respectively, find their ratio of intensities. (Consider frequency is constant)

(1) $\frac{25}{4}$

(2) $\frac{4}{25}$

(3) $\frac{16}{25}$

(4) $\frac{25}{16}$

7. Two waves of same frequency have intensities ratio $\frac{25}{16}$. If amplitude of 1^{st} wave is 5m, then amplitude of another wave is,

(1) 5m

(2) 16m

(3) 8m

(4) 4m

8. Identify the formula of intensity

(1) $\frac{1}{2}\rho\omega^2A^2v$

(2) $\frac{1}{2}\rho^2\omega^2A^2v$

(3) $\frac{1}{2}\rho^2\omega^2A^2v^2$

(4) $\frac{1}{2}\frac{\rho^2\omega^2A^2}{v}$

Answer Key

Question	1	2	3	4	5	6	7	8
Answer	3	1	1	2	1	2	4	1

SOLUTIONS

1. **(3)**

Power = $\frac{\text{Energy}}{\text{Time}}$

$E = p \times t$

$E = (512) \times (4)$

$E = 2048$ Joule

2. **(1)**

Energy of formula in terms of λ is given by $\frac{1}{2}\mu A^2\omega^2\lambda$

3. **(1)**

We know

Energy $= \frac{1}{2}\mu A^2\omega^2\lambda$

$= \frac{1}{2}(1)(10)^2(1)^2(1)$

$= \frac{100}{2}$

$= 50J$

4. **(2)**

$E = \frac{1}{2}\mu A^2\omega^2\lambda$

$1.26 \times 10^6 = \frac{1}{2}(7)(100 \times 100)(9)\lambda$

$1.26 \times 10^2 = \frac{7}{2}(9)\lambda$

$2.52 \times 10^2 = 7 \times 9\,\lambda$

$\boxed{\lambda = 4}$

5. **(1)**

$\frac{I_1}{I_2} = \frac{\omega_1^2 A_1^2}{\omega_2^2 A_2^2} \Rightarrow \frac{f_1^2 A_1^2}{f_2^2 A_2^2} \Rightarrow \frac{1}{4}\left(\frac{25}{4}\right) \Rightarrow \frac{25}{16} (\because \omega = 2\pi f)$

6. **(2)**

$I_A = f_1^2 A_1^2$
$I_B = f_2^2 A_2^2$

$$\frac{I_A}{I_B} = \left(\frac{A_1}{A_2}\right)^2$$
$$\frac{I_A}{I_B} = \frac{4}{25}$$

7. **(4)**

$$\frac{I_1}{I_2} = \frac{A_1^2 f_1^2}{A_2^2 f_2^2}$$
$$\frac{25}{16} = \frac{5^2}{A_2^2}$$
$$A_2^2 = 16$$
$$A_2 = 4m$$

8. **(1)**

Formula of intensity

$$I = \frac{1}{2}\rho\omega^2 A^2 v$$

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GDPP
GGSRDN DAILY PRACTICE PROBLEM

Speed of Mechanical Wave on String DPP-04

1. A wave moves with speed 300 m/s on a wire is under the tension of 500N. Find how much tension must be changed to increase the speed to 360 m/s.

(1) 210 N
(2) 240 N
(3) 230 N
(4) 220 N

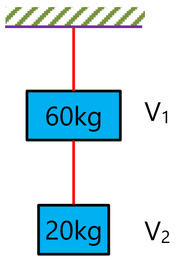
2. If velocity of wave produced in string 200 m/s and tension in string is 500 N. Find linear mass density?

(1) $\frac{4}{5} \times 10^{-2} \frac{\text{Kg}}{\text{m}}$
(2) $\frac{5}{4} \times 10^{-2} \frac{\text{Kg}}{\text{m}}$
(3) $2 \times 10^{-3} \frac{\text{Kg}}{\text{m}}$
(4) None of these

3. Two strings have tension ratio 16 : 4 and linear mass density ratio $\frac{4}{1}$, then find the ratio of velocity of transverse waves in strings?

(1) 6:7
(2) 5:4
(3) 2:1
(4) 1:1

4. Find the ratio of velocity of transverse wave in both identical wires?



(1) 2 : 3
(2) 2 : 1
(3) 3 : 2
(4) 1 : 2

5. A wire is 4 m long and has a mass = 0.2 kg. The wire is kept horizontally. A wave is generated by plucking one end of wire. If the wave pulse makes 4 trips back and forth in 0.4 sec. Find tension in wire.

(1) 260
(2) 160
(3) 320
(4) 180

6. Two wires of different densities but same area of cross section are joined together at their one end and other ends of wire are stretched to a tension T. If speed of transverse wave in one wire is double of other. Find out the ratio of densities.

(1) 4 : 1
(2) 2 : 3
(3) 3 : 2
(4) 1 : 4

Answer Key

Question	1	2	3	4	5	6
Answer	4	2	4	2	3	4

SOLUTIONS

1. **(4)**

$$V = \sqrt{\frac{T}{\mu}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\frac{300}{360} = \sqrt{\frac{500}{T_2}}$$

After solving this,

$T_2 = 720$ N

Now, $\Delta T = T_2 - T_1 = 720 - 500 = 220$ N

2. **(2)**

$$V = \sqrt{\frac{T}{\mu}}$$

$$200 = \sqrt{\frac{500}{\mu}}$$

$$40000 = \frac{500}{\mu}$$

$$\mu = \frac{500}{40000}$$

$$\mu = \frac{5}{4} \times 10^{-2} \frac{Kg}{m} \frac{Kg}{m}$$

3. **(4)**

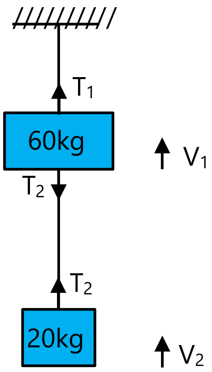
$$\frac{V_1}{V_2} = \frac{\sqrt{\frac{T_1}{\mu_1}}}{\sqrt{\frac{T_2}{\mu_2}}}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2}} \times \sqrt{\frac{\mu_2}{\mu_1}}$$

$$= \sqrt{\frac{16}{4}} \times \sqrt{\frac{1}{4}} = \sqrt{\frac{4}{1}} \times \sqrt{\frac{1}{4}}$$

$$\frac{V_1}{V_2} = \frac{1}{1}.$$

4. **(2)**

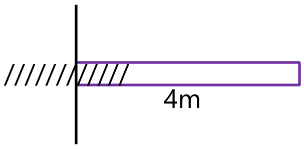


$$\frac{V_1}{V_2} = \frac{\sqrt{T_1}}{\sqrt{T_2}}$$

$$= \frac{V_1}{V_2} = \frac{\sqrt{80g}}{\sqrt{20g}} = \sqrt{4}$$

= 2 : 1

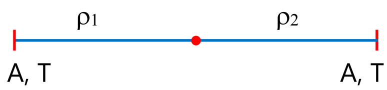
5. **(3)**



$$V = \frac{D}{t} = \frac{4\times8\times10}{4} = 80\text{m/s}$$

$$V = \sqrt{\frac{T}{\mu}} \Rightarrow 80 = \sqrt{\frac{T\times4\times10}{2}} \Rightarrow T = 320\text{N}$$

6. **(4)**



$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{A\rho}} \Rightarrow V \propto \sqrt{\frac{1}{\rho}}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{\rho_2}{\rho_1}} \Rightarrow \frac{2V}{V} = \sqrt{\frac{\rho_2}{\rho_1}} \Rightarrow 4:1 = \frac{\rho_2}{\rho_1} \Rightarrow \rho_1 : \rho_2 = 1:4$$

Sound Waves and it's Characteristics DPP-05

1. When the temperature of an ideal gas is increased by 600k, the velocity of sound in the gas becomes $\sqrt{3}$ times the initial velocity. The initial temperature of gas is

(1) –73°C
(2) 27°C
(3) 127°C
(4) 327°C

2. Frequency range of the audible sound is

(1) 0HZ – 30HZ
(2) 20HZ – 20KHZ
(3) 20KHZ – 20,000KHZ
(4) 20KHZ – 20MHZ

3. The speed of sound in gas of density ρ at a pressure P is proportional to

(1) $\left(\frac{P}{\rho}\right)^2$
(2) $\left(\frac{P}{\rho}\right)^{3/2}$
(3) $\sqrt{\frac{\rho}{P}}$
(4) $\sqrt{\frac{P}{\rho}}$

4. A microwave and ultra-sonic sound wave have the same wavelength in air. Their frequencies are in the ratio (approximately)

(1) $10^6 : 1$
(2) $10^4 : 1$
(3) $10^2 : 1$
(4) $10 : 1$

5. Velocity of sound waves in air is 330 m/s for a particular sound in air, if the path difference of 40 cm is equivalent to a phase difference of 1.6π , then the frequency of wave is

(1) 165 Hz
(2) 150 Hz
(3) 660 Hz
(4) 330 Hz

6. **Speed of sound in air**
(i) increase with temperature
(ii) remain constant with decrease in temperature
(iii) increase with pressure at constant temperature
(iv) is independent of pressure at constant temperature
(1) only (i) & (ii) are true
(2) only (i) & (iii) are true
(3) only (ii) & (iii) are true
(4) only (i) & (iv) are true

7. **Two monoatomic ideal gases 1 and 2 of molecular masses m_1 & m_2 respectively are enclosed in separate containers kept at the same temperature. The ratio of the speed of sound in gas 1 to that in gas 2 is -**
(1) $\sqrt{\frac{m_1}{m_2}}$
(2) $\sqrt{\frac{m_2}{m_1}}$
(3) $\frac{m_1}{m_2}$
(4) $\frac{m_2}{m_1}$

8. **It takes 2 sec for a sound wave to travel between two fixed points when the day temperature is 10°C. If the temperature rises to 30°C then sound wave travels between the same fixed part in**
(1) 1.9 sec
(2) 2.0 sec
(3) 2.1 sec
(4) 2.2 sec

9. **The ratio of the speed of sound in oxygen to that in hydrogen at same temperature and pressure is approximately**
(1) 16:1
(2) 1:16
(3) 4:1
(4) 1:4

10. **If the temperature is raised by 1K from 300K the percentage change in the speed of sound in the gaseous mixture (R = 8.31 J/mol-H)**
(1) 0.167%
(2) 0.334%
(3) 1%
(4) 2%

11. **'SONAR' emits which of the following wave**
(1) Radio waves
(2) Ultrasonic waves
(3) Light waves
(4) Magnetic waves

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11
Answer	2	2	4	1	3	4	2	1	4	1	2

SOLUTIONS

1. **(2)**

By using $v = \sqrt{\frac{\gamma RT}{M}} \Rightarrow v \propto \sqrt{T}$

$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{T+600}{T}} = \sqrt{3}$

$\Rightarrow$ T = 300 K = 27°C

2. **(2)**

3. **(4)**

The speed of sound in a gas of density ρ at pressure P is

$v = \sqrt{\frac{\gamma P}{\rho}}$

4. **(1)**

$n \propto v \Rightarrow \frac{n_{MW}}{n_{US}} = \frac{v_{MW}}{v_{US}} = 10^6 : 1$

5. **(3)**

$1.6\pi = \frac{2\pi}{\lambda} \times \frac{40}{100}$

$\lambda = \frac{40}{0.8} \Rightarrow$ 0.5 m

$v = f\lambda$

$\Rightarrow f = \frac{v}{0.5} = \frac{330}{0.5}$ m= 660 Hz.

6. **(4)**

Speed of sound $v \propto \sqrt{T}$ and it is independent of pressure

7. **(2)**

Speed of sound in gases is given by

$v = \sqrt{\frac{\gamma RT}{M_W}} \therefore \frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$

8. **(1)**

Velocity of sound $v \propto \sqrt{T}$

$\left(\text{Time} = \frac{\text{Distance}}{\text{Speed}}\right)$

$\therefore t \propto \frac{1}{\sqrt{T}}$

$\frac{t_1}{t_2} = \sqrt{\frac{T_2}{T_1}}$

$\frac{2}{t_2} = \sqrt{\frac{273+30}{273+10}}$

$\frac{2}{t_2} = \sqrt{\frac{303}{283}} = 1.03$

$t_2 = \frac{2}{1.03} = 1.9s$

9. **(4)**

According to Laplace, the speed of sound in gas is given by

$v = \sqrt{\frac{\gamma RT}{M_W}}$

$\therefore \frac{v_{O_2}}{v_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}}$

$\therefore \frac{v_{O_2}}{v_{H_2}} = \sqrt{\frac{2}{32}} = \frac{1}{4}$

$\therefore v_{O_2} : v_{H_2} = 1:4$

10. **(1)**

From $v = \sqrt{\frac{\gamma RT}{M_W}}$

$\frac{\Delta v}{v} = \frac{1}{2}\frac{\Delta T}{T}$

$\frac{\Delta v}{v} \times 100 = \frac{1}{2}\left(\frac{\Delta T}{T}\right) \times 100$

$= \frac{1}{2} \times \frac{1}{300} \times 100 = 0.167\%$

11. **(2)**

SONAR emits ultrasonic waves.

Interference of Waves DPP-06

1. During interference of waves the amplitude of the resulting wave can be found at any position using the principle of

(1) Superposition
(2) Interference
(3) Diffraction
(4) None of these

2. During interference phenomenon of two waves, it is observed that maximum amplitude to minimum amplitude ratio $\left(\frac{A_{max}}{A_{min}}\right)$ is 9:7. Find the intensity ratio of waves

(1) 1:64
(2) 64:1
(3) 1:4
(4) 4:1

3. Two waves having intensity ratio 9:1 produce interference. The ratio of maximum to minimum intensity is

(1) 1:4
(2) 4:1
(3) 16:1
(4) 1:16

4. Interference phenomenon can take place

(1) in transverse wave
(2) in longitudinal wave
(3) in electromagnetic wave
(4) in all waves

5. Four different independent waves are represented by

(A) $y_1 = a_1 \sin\omega_1 t$ (B) $y_2 = a_2 \sin\omega_2 t$ (C) $y_3 = a_3 \sin\omega_3 t$ (D) $y_4 = a_4 \sin \omega_4 t$

The interference is possible due to

(1) A and B
(2) B and C
(3) C and D
(4) None of these

6. When two sound waves with a phase difference of $\frac{\pi}{2}$, and each having amplitude A and frequency ω, are superimposed on each other, then the maximum amplitude and frequency of resultant wave is

(1) $\frac{A}{\sqrt{2}} : \frac{\omega}{2}$

(2) $\frac{A}{\sqrt{2}} : \omega$

(3) $\sqrt{2}A : \frac{\omega}{2}$

(4) $\sqrt{2}A : \omega$

7. If the phase difference between the two wave is 2π during superposition, then the resultant amplitude is

(1) Maximum

(2) Minimum

(3) Maximum or minimum

(4) None of the above

8. The superposition takes place between two waves of frequency f and amplitude a in same phase. The maximum intensity is directly proportional to

(1) a

(2) 2a

(3) $2a^2$

(4) $4a^2$

9. If two waves of same frequency and same amplitude respectively, on superimposition produced a resultant disturbance of the same amplitude, the waves differ in phase by

(1) π

(2) $2\pi/3$

(3) $\pi/2$

(4) Zero

10. Two sound waves (expressed in CGS units) given by $y_1 = 0.3\sin\frac{2\pi}{\lambda}(vt - x)$ and $y_2 = 0.4\sin\frac{2\pi}{\lambda}(vt - x)$ interfere. The resultant amplitude at a place where phase difference is $\pi/2$ will be

(1) 0.7 cm

(2) 0.1 cm

(3) 0.5 cm

(4) $\frac{1}{10}\sqrt{7}$cm

11. **If two waves having amplitudes $2A$ and A and same frequency and velocity, propagate in the same direction in the same phase, the resulting amplitude will be**

(1) $3A$

(2) $\sqrt{5}A$

(3) $\sqrt{2}A$

(4) A

12. **The superposing waves are represented by the following equations:**

$y_1 = 5\sin 2\pi(10t - 0.1x), y_2 = 10\sin 2\pi(10t - 0.1x)$. Ratio of intensities $\frac{I_{max}}{I_{min}}$ will be

(1) 1

(2) 9

(3) 4

(4) 16

13. **If the ratio of amplitude of wave is 2 : 1, then the ratio of maximum and minimum intensity is**

(1) 9 : 1

(2) 1 : 9

(3) 4 : 1

(4) 1 : 4

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13
Answer	1	2	2	4	4	4	1	4	2	3	1	2	1

SOLUTIONS

1. **(1)**

Superposition principle.

2. **(2)**

$\frac{A_1}{A_2} = \frac{9}{7}$

$\frac{I_1}{I_2} = \frac{I_{max}}{I_{min}}$

$= \frac{(9+7)^2}{(9-7)^2}$

$= \frac{(16)^2}{(2)^2} = 64$

3. **(2)**

Let the intensities of two waves be

I_1 and I_2

Given $I_1 : I_2 = 9 : 1$

$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}$

$= \left(\frac{\sqrt{9}+1}{\sqrt{9}-1}\right)^2$

$= \frac{16}{4} = \frac{4}{1}.$

4. **(4)**

Interference phenomenon happens when two waves meet, it occurs in all waves irrespective of its nature.

5. **(4)**

Interference take place during the interactive of waves that have same frequency. Four different independent waves have frequencies $\omega_1, \omega_2, \omega_3$ and ω_4 respectively.

As these frequencies are different, the interference does not take place between any combinations. Hence, option (4) is correct.

6. **(4)**

$A_{max} = \sqrt{A^2 + A^2} = A\sqrt{2}$, frequency will remain same i.e. ω.

7. **(1)**

Phase difference is 2π means constrictive interference so resultant amplitude will be maximum.

8. **(4)**

Resultant amplitude

$A = \sqrt{a^2 + a^2 + 2aa\cos\varphi} = \sqrt{4a^2\cos^2\left(\frac{\varphi}{2}\right)}$

$\because I \propto A^2 \Rightarrow I \propto 4a^2$

9. **(2)**

$a^2 = a^2 + a^2 + 2a^2\cos\theta \Rightarrow \cos\theta = -\frac{1}{2} \Rightarrow \theta = \frac{2\pi}{3}$

10. **(3)**

Resultant amplitude $= \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\varphi}$

$= \sqrt{0.3^2 + 0.4^2 + 2 \times 0.3 \times 0.4 \times \cos\frac{\pi}{2}} = 0.5$ cm

11. **(1)**

In the same phase $\phi = 0$ so resultant amplitude $= a_1 + a_2 = 2A + A = 3A$

12. **(2)**

$a_1 = 5, a_2 = 10 \Rightarrow \frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2} = \left(\frac{5+10}{10-5}\right)^2 = \frac{9}{1}$

13. **(1)**

$\frac{I_{max}}{I_{min}} = \left(\frac{2+1}{2-1}\right)^2 = 9/1$

Beats DPP-07

1. Two waves are represented by $y_1 = 4\sin 404\pi t$ and $y_2 = 3\sin 400\pi t$. Then

(1) Beat frequency is 4 Hz and the ratio of maximum to minimum intensity is 49:1

(2) Beat frequency is 2 Hz and the ratio of maximum to minimum intensity is 49:1

(3) Beat frequency is 2 Hz and the ratio of maximum to minimum intensity is 1:49

(4) Beat frequency is 4 Hz and the ratio of maximum to minimum intensity is 1:49

2. Beats are the result of

(1) Diffraction

(2) Destructive interference

(3) Constructive and destructive interference

(4) Superposition of two waves of nearly equal frequency

3. Beats are produced by frequencies v_1 and $v_2 (v_1 > v_2)$. The duration of time between two successive maximum or minima is equal to

(1) $\frac{1}{v_2+v_2}$

(2) $\frac{2}{v_2-v_2}$

(3) $\frac{2}{v_1+v_2}$

(4) $\frac{1}{v_1-v_2}$

4. Two adjacent piano keys are struck simultaneously. The notes emitted by them have frequencies n_1 and n_2. The number of beats heard per second is

(1) $\frac{1}{2}(n_1 - n_2)$

(2) $\frac{1}{2}(n_1 + n_2)$

(3) $n_1 \sim n_2$

(4) $2(n_1 \sim n_2)$

5. Two vibrating tuning forks produce progressive waves given by $Y_1 = 4\sin 500\pi t$ and $Y_2 = 2\sin 506\pi t$. Number of beats produced per minute is

(1) 360

(2) 180

(3) 3

(4) 60

6. Beats are produced by two waves given by $y_1 = a\sin(2000\pi)t$ and $y_2 = a\sin(2008\pi)t$. The number of beats heard per second is

(1) Zero

(2) One

(3) Four

(4) Eight

7. Two tuning forks when sounded together produced 4 beats/sec. The frequency of one fork is 256 Hz. The number of beats heard increases when the fork of frequency 256 Hz is loaded with wax. The frequency of the other fork is

(1) 504 Hz

(2) 520 Hz

(3) 260 Hz

(4) 252 Hz

8. A tuning fork vibrates with 2 beats in 0.04 second. The frequency of the fork is

(1) 50 Hz

(2) 100 Hz

(3) 80 Hz

(4) None of these

9. In Quincke's experiment the sound detected is changed from a maximum to a minimum when the sliding tube is moved through a distance of 2.50 cm. Find the frequency of sound if the speed of sound in air is 340 m/s

(1) 3.2 KHz

(2) 3.4 KHz

(3) 5.3 Hz

(4) 5.3 KHz

10. In Quincke's experiment, the sound intensity has minimum value I at a particular position. As the sliding tube is pulled out by a distance of 16.5 mm. The intensity increases to a maximum of 9I take speed of sound in air to be 330 m/s. Find the frequency of sound source.

(1) 10 KHz

(2) 5 KHz

(3) 3 KHz

(4) 2 KHz

11. Two tuning forks have frequencies 450 Hz and 454 Hz respectively. On sounding these forks together, the time interval between successive maximum intensities will be

(1) 1/4 sec
(2) 1/2 sec
(3) 1 sec
(4) 2 sec

12. A tuning fork gives 5 beats with another tuning fork of frequency 100 Hz. When the first tuning fork is loaded with wax, then the number of beats remains unchanged, then what will be the frequency of the first tuning fork

(1) 95 Hz
(2) 100 Hz
(3) 105 Hz
(4) 110 Hz

13. Two tuning forks, A and B, give 4 beats per second when sounded together. The frequency of A is 320 Hz. When some wax is added to B and it is sounded with A, 4 beats per second are again heard. The frequency of B is

(1) 312 Hz
(2) 316 Hz
(3) 324 Hz
(4) 328 Hz

14. It is possible to hear beats from the two vibrating sources of frequency

(1) 100 Hz and 150 Hz
(2) 20 Hz and 25 Hz
(3) 400 Hz and 500 Hz
(4) 1000 Hz and 1500 Hz

15. When a tuning fork vibrates, the waves produced by the prongs of fork in air is -

(1) Longitudinal
(2) Transverse
(3) Progressive
(4) Stationary

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	2	4	4	4	2	3	3	1	2	2	1	3	3	2	1

SOLUTIONS

1. **(2)**

Given $y_1 = 4\sin(404\pi t)$ and $y_2 = 4\sin(400\pi t)$

$\omega_1 = 404\pi$ and $\omega_2 = 400\pi$

$2\pi f_1 = 404\pi$ and $2\pi f_2 = 400\pi$

$f_1 = 202$ Hz and $f_2 = 200$ Hz

Beat frequency $\Rightarrow f_1 - f_2 = 2$Hz

$$\frac{I_{max}}{I_{min}} = \frac{(A_1+A_2)^2}{(A_1-A_2)^2} = \left(\frac{4+3}{4-3}\right)^2 = \frac{49}{1}.$$

2. **(4)**

3. **(4)**

The time-interval between two successive beats

$$T = \frac{1}{\text{beat frequency}} = \frac{1}{\nu_1-\nu_2}.$$

4. **(3)**

The number of beats heard is given by difference in frequencies of the notes B = $n_1 \sim n_2$

5. **(2)**

From the given equations of progressive waves $\omega_1 = 500\pi$ and $\omega_2 = 506\pi$ $\therefore$ $n_1 = 250$ Hz and $n_2 = 253$ Hz

So, beat frequency $= n_2 - n_1 = 253 - 250 = 3$ beats per sec

$\therefore$ Number of beats per min = 180.

6. **(3)**

Number of beats per second = $n_1 \sim n_2$

$\omega_1 = 2000\pi \Rightarrow 2\pi n_1 \Rightarrow n_1 = 1000$Hz and $\omega_2 = 2008\pi = 2\pi n_2 \Rightarrow n_2 = 1004$Hz

Number of beats heard per second

$\Rightarrow 1004 - 1000 = 4$

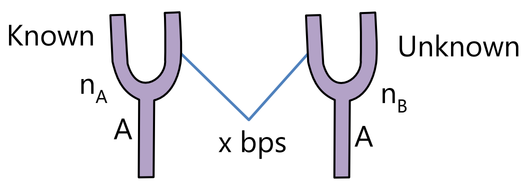
7. **(3)**

Suppose two tuning forks are named A and B with frequencies $n_A = 256$Hz, n =? (unknown), and beat frequency x = 4bps

Frequency of unknown tuning fork

$n_B = 256 + 4 = 260$ or $256 - 4 = 252$.

When loaded with wax, $n_B = 256 + 4 = 260$ Hz



8. **(1)**

Frequency $\Rightarrow \frac{\text{number of beats}}{\text{time}} = \frac{2}{0.04}$= 50 Hz.

9. **(2)**

Distance between maximum to a minimum is given by $\frac{\lambda}{4}$ = 2.50 cm.

$\lambda = 10$ cm

$\lambda = 10^{-1}$m

We know

$v = n\lambda$

$n = \frac{v}{\lambda} = \frac{340}{10^{-1}}$

= 3400 Hz

= 3.4 KHz.

10. **(2)**

d = 16.5 mm

$\lambda = 16.5 \times 4\text{mm}$

$\lambda = 66 \times 10^{-3}\text{m}$

$v = 330\text{m/s}$

$f = \frac{v}{\lambda} = \frac{330}{66 \times 10^{-3}}$

$f = 5 \times 10^3$

$f = 5\text{KHz}$

11. **(1)**

The time interval between successive maximum intensities will be $\frac{1}{n_1 \sim n_2} = \frac{1}{454-450} = \frac{1}{4}$sec.

12. **(3)**

Suppose $n_A = \text{known frequency} = 100 \text{ Hz}, n_B = ?$

x = 5 bps, which remains unchanged after loading

Unknown tuning fork is loaded so $n_B \downarrow$

Hence $n_A - n_B \downarrow = x$ ... (i)

$n_B \downarrow - n_A = x$ ... (ii)

From equation (i), it is clear that as n_B decreases, beat frequency. (i.e. $n_A - (n_B)_{new}$) can never be x again. From equation (ii), as $n_B \downarrow$, beat frequency (i.e. $(n_B)_{new} - n_A$) decreases as long as $(n_B)_{new}$ remains greater than n_A, If $(n_B)_{new}$) become lesser than n_A the beat frequency will increase again and will be x. Hence this is correct.

So, $n_B = n_A + x = 100 + 5 = 105$ Hz.

13. **(3)**

$n_A - n_B \downarrow = \text{ x (same)} \ \ldots \text{(i)}$ → Wrong

$n_B \downarrow - n_A = \text{ x (same)} \ \ldots \text{(ii)}$ → Correct

$\Rightarrow n_B = n_A + x = 320 + 4 = 324$ Hz.

14. **(2)**

For hearing beats, difference of frequencies should be approximately 10 Hz.

15. **(1)**

Theory based.

Transverse Stationary Waves DPP-08

1. A standing wave having 7 nodes and 6 antinodes is formed between 6Å distance then the wavelength is

(1) 3Å
(2) 2Å
(3) 5Å
(4) 1

2. A stretched string which is fixed at both ends has n nodes, then the length of the string is

(1) $(2n-1)\lambda$
(2) $(n-1)\frac{\lambda}{2}$
(3) $(n+1)\frac{\lambda}{2}$
(4) $(2n+1)\frac{\lambda}{2}$

3. The distance between the nearest node and antinode in a stationary wave is

(1) λ
(2) $\frac{\lambda}{2}$
(3) $\frac{\lambda}{4}$
(4) 2λ

4. The phase difference between the two particles situated on both the sides of a node is

(1) 0°
(2) 90°
(3) 180°
(4) 360°

5. Stationary waves are formed when

(1) Two waves of equal amplitude and equal frequency travel along the same path in opposite directions
(2) Two waves of equal wavelength and equal amplitude travel along the same path with equal speeds in opposite directions
(3) Two waves of equal wavelength and equal phase travel along the same path with equal speed
(4) Two waves of equal amplitude and equal speed travel along the same path in opposite direction

6. For the stationary wave $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$, the distance between a node and the next antinode is

(1) 7.5
(2) 15
(3) 22.5
(4) 30

7. The equation of stationary wave along a stretched string is given by $y = 5\sin\frac{\pi x}{3}\cos 40\pi t$, where x and y are in cm and t in second. The separation between two adjacent nodes is

(1) 1.5 cm
(2) 3 cm
(3) 6 cm
(4) 4 cm

8. The equation of a stationary wave is $y = 0.8\cos\left(\frac{\pi x}{20}\right)\sin 200\pi t$, where x is in cm and t is in sec. The separation between consecutive nodes will be

(1) 20 cm
(2) 10 cm
(3) 40 cm
(4) 30 cm

9. In a stationary wave, all particles are

(1) At rest at the same time twice in every period of oscillation
(2) At rest at the same time only once in every period of oscillation
(3) Never at rest at the same time
(4) Never at rest at all

10. The equation y = 0.15 sin5xcos300t, describes a stationary wave. The wavelength of the stationary wave is

(1) Zero
(2) 1.256 metres
(3) 2.512 metres
(4) 0.628 metre

11. A standing wave is represented by, $Y = A\sin(100t)\cos(0.01x)$, where Y and A are in millimetre, t is in seconds and x is in metre. The velocity of wave is

(1) 10^4 m/s
(2) 1 m/s
(3) 10^{-4} m/s
(4) Not derivable from above data

12. When a stationary wave is formed then its frequency is

(1) Same as that of the individual waves
(2) Twice that of the individual waves
(3) Half that of the individual waves
(4) None of the above

13. In stationary waves

(1) Energy is uniformly distributed
(2) Energy is minimum at nodes and maximum at antinodes
(3) Energy is maximum at nodes and minimum at antinodes
(4) Alternating maximum and minimum energy producing at nodes and antinodes

14. Equation of a stationary wave is $y = 10\sin\frac{\pi x}{4}\cos 20\pi t$. Distance between two consecutive nodes is

(1) 4
(2) 2
(3) 1
(4) 8

15. Two travelling waves $y_1 = A\sin[k(x - ct)]$ and $y_2 = A\sin[k(x + ct)]$ are superimposed on string. The distance between adjacent nodes is

(1) ct/π
(2) ct/2π
(3) π/2k
(4) π/k

16. A string vibrates according to the equation $y = 5\sin\left(\frac{2\pi x}{3}\right)\cos 20\pi t$, where x and y are in cm and t in sec. The distance between two adjacent nodes is

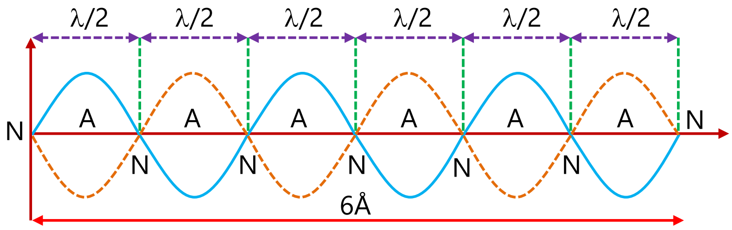
(1) 3 cm
(2) 4.5 cm
(3) 6 cm
(4) 1.5 cm

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	2	2	3	3	2	1	2	1	1	2	1	1	2	1	4
Question	16														
Answer	4														

SOLUTIONS

1. **(2)**



$3\lambda = 6Å \Rightarrow \lambda = 2Å$

2. **(2)**

n = 2 (node)

$\ell = \frac{\lambda}{2}$

n = 3

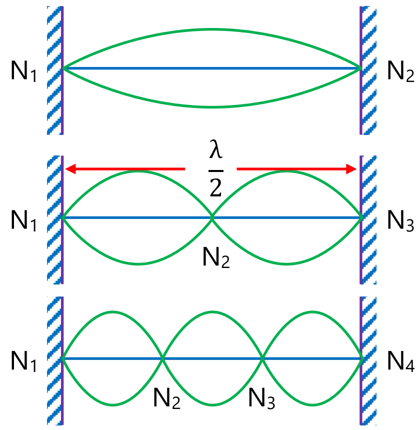
$\ell = \lambda$

n = 4

$\ell = \frac{3\lambda}{2}$

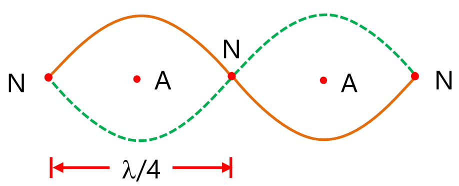
If number of nodes = n

Thus, $\ell = (n-1)\frac{\lambda}{2}$



3. **(3)**

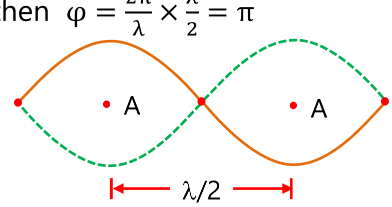
The distance between the nearest node and antinode in a stationary wave is $\frac{\lambda}{4}$



4. **(3)**

Both the sides of a node, two antinodes are present with separation $\frac{\lambda}{2}$

So, phase difference between then $\varphi = \frac{2\pi}{\lambda} \times \frac{\lambda}{2} = \pi$



5. **(2)**

6. **(1)**

Comparing given equation with standard equation $y = 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi vt}{\lambda}$ gives us $\frac{2\pi}{\lambda} = \frac{\pi}{15} \Rightarrow \lambda = 30$

Distance between nearest node and antinodes = $\frac{\lambda}{4} = \frac{30}{4} = 7.5$

7. **(2)**

On comparing the given equation with standard equation $y = 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi vt}{\lambda} \Rightarrow \frac{2\pi x}{\lambda} = \frac{\pi x}{3} \Rightarrow \lambda = 6$

Separation between two adjacent nodes = $\frac{\lambda}{2} = 3\text{cm}$

8. **(1)**

On comparing the given equation with standard equation $y = 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi vt}{\lambda}$

We get $\frac{2\pi}{\lambda} = \frac{\pi}{20} \Rightarrow \lambda = 40$

Separation between two consecutive nodes = $\frac{\lambda}{2} = \frac{40}{2} = 20\ \text{cm}$

9. **(1)**

10. **(2)**

On comparing the given equation with standard equation $\frac{2\pi}{\lambda} = 5 \Rightarrow \lambda = \frac{6.28}{5} = 1.256\text{m}$

11. **(1)**

By comparing given equation with $y = a\sin(\omega t)\cos kx$

$\Rightarrow v = \frac{\omega}{k} = \frac{100}{0.01} = 10^4\, m/s$

12. **(1)**

If $y_{\text{incident}} = a\sin(\omega t - kx)$ and $y_{\text{stationary}} = a\sin(\omega t)\cos kx$

then it is clear that frequency of both is same (ω)

13. **(2)**

14. **(1)**

On comparing the given equation with standard equation $\frac{2\pi}{\lambda} = \frac{\pi}{4} \Rightarrow \lambda = 8$

Hence distance between two consecutive nodes $\frac{\lambda}{2} = 4$

15. **(4)**

The distance between adjacent nodes $x = \frac{\lambda}{2}$

Also $k = \frac{2\pi}{\lambda}$. Hence $x = \frac{\pi}{k}$.

16. **(4)**

$y = 5\sin\left(\frac{2\pi x}{3}\right)\cos 20\,\pi\, t$, comparing with equation

$y = 2a\sin\frac{2\pi x}{\lambda}\cos\frac{2\pi vt}{\lambda} \Rightarrow \lambda = 3$, distance between two adjacent nodes $= \lambda/2 = 1.5\text{cm}$.

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GDPP
GGSRDN DAILY PRACTICE PROBLEM

Sonometer DPP-09

1. Fundamental frequency of sonometer wire is n. If the length, tension and diameter of wire are tripled, then new fundamental frequency is

(1) $\frac{n}{\sqrt{3}}$
(2) $\frac{n}{3}$
(3) $n\sqrt{3}$
(4) $\frac{n}{3\sqrt{3}}$

2. When a string is divided into three segment of length ℓ_1, ℓ_2 and ℓ_3 the fundamental frequency of these three segment are v_1, v_2 and v_3 respectively, the original frequency of the string is

(1) $\sqrt{v} = \sqrt{v_1} + \sqrt{v_2} + \sqrt{v_3}$
(2) $v = v_1 + v_2 + v_3$
(3) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$
(4) $\frac{1}{\sqrt{v}} = \frac{1}{\sqrt{v_1}} + \frac{1}{\sqrt{v_2}} + \frac{1}{\sqrt{v_3}}$

3. A sonometer wire emits a fundamental note of frequency 150 Hz. Calculate the frequency of note emitted when the tension is change in the ratio of 9 : 16 and length in the ratio of 1:2

(1) 100 Hz
(2) 120 Hz
(3) 130 Hz
(4) 200 Hz

4. If the tension in a sonometer wire is increased by a factor of four then fundamental frequency of vibration changes by a factor of :

(1) 4
(2) 1/4
(3) 2
(4) 1/2

5. Four wires of identical lengths, diameters and of the same material are stretched on a sonometer wire. The ratio of their tension is 1 : 4 : 9 : 16. The ratio of their fundamental frequencies is

(1) 1 : 2 : 3 : 4
(2) 16 : 9 : 4 : 1
(3) 1 : 4 : 9 : 16
(4) 4 : 3 : 2 : 1

6. **The fundamental frequency of a sonometer wire increases by 10 Hz, if its tension is increased by 96%, keeping the length constant. Find the change in fundamental frequency of the sonometer wire, when the length of wire is increased by 25 %, keeping the original tension in the wire.**

(1) 6 Hz

(2) 5 Hz

(3) 7 Hz

(4) 9 Hz

7. **Length of a sonometer wire is either 60 cm or 80 cm, in both the cases a tuning fork produces 3 beats. Then find the frequency of tuning fork.**

(1) 12 Hz

(2) 15 Hz

(3) 21 Hz

(4) 18 Hz

Answer Key

Question	1	2	3	4	5	6	7
Answer	4	3	1	3	1	2	3

SOLUTIONS

1. **(4)**

We know,

$$n = \frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2 \rho}}$$

$$n \propto \frac{\sqrt{T}}{\ell r}$$

$$\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}\left(\frac{\ell_2}{\ell_1}\right)\left(\frac{r_2}{r_1}\right)$$

$$= \sqrt{\frac{T}{3T}} \times \frac{3\ell}{\ell} \times \frac{3r}{r}$$

$$\boxed{n_2 = \frac{n}{3\sqrt{3}}}$$

2. **(3)**

Fundamental frequency is given by

$$v = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} \Rightarrow v \propto \frac{1}{\ell}$$

Here $\ell = \ell_1 + \ell_2 + \ell_3$

$$\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$$

3. **(1)**

$n_1 = 150\text{Hz}$ $\qquad$ $n_2 = ?$

$\frac{T_1}{T_2} = \frac{9}{16}$ $\qquad$ & $\qquad$ $\frac{\ell_1}{\ell_2} = \frac{1}{2}$

$$\frac{n_2}{n_1} = \frac{\frac{1}{2\ell_2}\sqrt{\frac{T_2}{\mu_2}}}{\frac{1}{2\ell_1}\sqrt{\frac{T_1}{\mu_1}}}$$

$$\frac{n_2}{n_1} = \frac{\ell_1}{\ell_2}\sqrt{\frac{T_2}{T_1}}$$

$$= \frac{1}{2}\sqrt{\frac{16}{9}} = \frac{2}{3}$$

$$n_2 = \frac{2}{3}n_1 = \frac{2}{3} \times 150$$

$n_2 = 100$ Hz

4. (3)

$n \propto \sqrt{T}$

$n' \propto \sqrt{4T}$

$\frac{n'}{n} = \sqrt{\frac{4T}{T}}$

$n' = 2n$

5. (1)

$n \propto \sqrt{T}$

$n_1 : n_2 : n_3 : n_4 = \sqrt{T_1} : \sqrt{T_2} : \sqrt{T_3} : \sqrt{T_4}$

$n_1 : n_2 : n_3 : n_4 = \sqrt{1} : \sqrt{4} : \sqrt{9} : \sqrt{16}$

$= 1 : 2 : 3 : 4$

6. (2)

$$T' = T + \frac{96}{100}T = 1.96T$$

$f \propto \sqrt{T}$

$$\frac{f + 10}{f} = \sqrt{\frac{1.96T}{T}}$$

$f + 10 = 1.4f$

$f = 25\text{Hz}$

Now, $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

$$\frac{f_1}{f_2} = \frac{\ell_2}{\ell_1} = \frac{\ell + 0.25\ell}{\ell}$$

$$f_2 = \frac{25}{1.25} = 20\text{Hz}$$

Change in frequency=25 - 20 = 5 Hz

7. (3)

$f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

$f \propto \frac{1}{\ell}$

$\frac{f_1}{f_2} = \frac{\ell_2}{\ell_1}$

$\frac{f+3}{f-3} = \frac{80}{60}$ (f is the frequency of tuning fork)

f = 21Hz

Longitudinal Stationary Waves and Closed Organ Pipe DPP-10

1. **Two closed organ pipes. When sounded simultaneously give 4 beats per second. If longer pipe has a length of 1m. Then length of shorter pipe will be (velocity of sound = 300m/s)**

(1) 185.5 cm
(2) 94.9 cm
(3) 90 cm
(4) 80 cm

2. **Two closed pipes produce 10 beats per second when emitting their fundamental nodes. If their lengths are in ratio of 25:26 respectively, then their fundamental frequency in Hz are**

(1) 270, 280 Hz
(2) 260, 270 Hz
(3) 260, 250 Hz
(4) 260, 280 Hz

3. **An air column in a pipe, which is closed at one end, will be in resonance with a vibrating body of frequency 332 Hz, if the length of air column is (velocity of sound v = 332 m/s)**

(1) 2.00 m
(2) 3.00 m
(3) 1.00 m
(4) 0.25 m

4. **Find the fundamental frequency of closed pipe, if the length of the air column is 42m. (speed of sound in air = 336 m/sec.)**

(1) 2 Hz
(2) 4 Hz
(3) 7 Hz
(4) 9 Hz

5. **If fundamental frequency of closed organ pipe is 50 Hz, then frequency of 2^{nd} overtone is**

(1) 100 Hz
(2) 50 Hz
(3) 250 Hz
(4) 150 Hz

6. **Two organ pipes are each closed at one end gives 5 beats/sec when emitting their fundamental notes. If their fundamental frequencies are 250 Hz and 255 Hz, then the ratio of their length will be,**

(1) $\frac{49}{50}$

(2) $\frac{49}{52}$

(3) $\frac{52}{51}$

(4) $\frac{51}{50}$

7. **The fundamental frequency produced by a closed organ pipe is 100 Hz. What are the frequencies of the first and second overtone?**

(1) 300 Hz, 500 Hz

(2) 750 Hz, 700 Hz

(3) 500 Hz, 200 Hz

(4) 100 Hz, 200 Hz

Answer Key

Question	1	2	3	4	5	6	7
Answer	2	3	4	1	3	4	1

SOLUTIONS

1. **(2)**

Number of beats = 4

So now for the longer pipe frequency = $\frac{\text{velocity of sound}}{4\times\text{lenght of longer pipe}}$

$f_1 = \frac{300}{4\times 1} \Rightarrow$ 75 Hz

As the number of beats is 4, then the frequency of shorter pipe would be either 75 + 4 or 75 – 4.

So as the pipe is shorter the frequency would be more therefore, frequency would be 79 Hz.

$f_2 = \frac{\text{velocity of sound}}{4\times\text{length of pipe}}$

$f_2 = \frac{300}{4\ell} \Rightarrow \ell = \frac{75}{79}$

ℓ = 0.949 m = 94.9 cm

2. **(3)**

We know that the fundamental frequency of a closed end pipe is given by,

$f = \frac{v}{4\ell}$

$f_1 = \frac{v}{4\ell_1}$ and $f_2 = \frac{v}{4\ell_2}$

$\frac{f_1}{f_2} = \frac{\ell_2}{\ell_1} = \frac{26}{25}$

Now beat $\Rightarrow$ $f_1 - f_2$ = 10 Hz

$\frac{26}{25}f_2 - f_2 = 10 \text{ Hz}$

$f_2 = 250 \text{ Hz}$

$f_1 = \frac{26}{25}\times f_2 \Rightarrow f_1 = \frac{26}{25}\times 250$

$\Rightarrow$ 260 Hz

3. **(4)**

Given v = 332 m/s

f = 332 Hz

$f = \frac{v}{4\ell}$

332 = $\frac{v}{4\ell} \Rightarrow \ell = \frac{332}{332\times 4} = \frac{1}{4} = 0.25\text{m}$

4. **(1)**

For closed pipe

$f = \frac{v}{4\ell}$

$f = \frac{336}{4\times 42}$ = 2 Hz.

5. **(3)**

Fundamental frequency $f_0 = \frac{v}{4\ell}$

Second overtone = $5f_0$

$\Rightarrow 5\times 50 \Rightarrow$ 250 Hz

6. (4)

Fundamental frequency of closed organ pipe = $\frac{v}{4\ell}$

Let for first pipe's length = ℓ_1

Frequency f_1 = 250 Hz

For 2^{nd} pipe's length $= \ell_2$

Frequency f_2 = 255 Hz

$$\frac{f_1}{f_2} = \frac{\frac{v}{4\ell_1}}{\frac{v}{4\ell_2}} = \frac{\ell_2}{\ell_1}$$

$$\frac{250}{255} = \frac{\ell_2}{\ell_1} \Rightarrow \frac{50}{51} = \frac{\ell_2}{\ell_1}$$

$$\Rightarrow \boxed{\frac{\ell_1}{\ell_2} = \frac{51}{50}}$$

7. (1)

Given f = 100 Hz

For first overtone, Let the frequency be f_1

i.e., $f_1 = 3f$

$f_1 = 3 \times 100$

f_1 = 300 Hz

For second overtone, Let the frequency be f_2

i.e. f_2 = 5f

$= 5 \times 100 = 500$ Hz.

Open Organ Pipe DPP - 11

1. **The length of two open organ pipe are ℓ and $(\ell + \Delta\ell)$ respectively, neglecting the end correction, the frequency of beats between them will be approximately (given that $\Delta\ell <<<< \ell$)**

(1) $\frac{v}{2\ell}$

(2) $\frac{v}{4\ell}$

(3) $\frac{v\Delta\ell}{2\ell^2}$

(4) $\frac{v\Delta\ell}{\ell}$

2. **What is minimum length of the tube, open at both ends that resonates with a tuning fork of frequency 350Hz (Velocity of sound 350 m/sec)?**

(1) 50 cm

(2) 100 cm

(3) 75 cm

(4) 25 cm

3. **An open organ pipe is producing third harmonic, then the number of nodes are**

(1) 1

(2) 2

(3) 3

(4) 4

4. **An organ pipe open from both ends produces 5 beats per second when vibrated with a source of frequency 200 Hz. The second harmonic of the same pipe produces 10 beats per second with a source of frequency 420 Hz. The fundamental frequency of the organ pipe is**

(1) 195 Hz

(2) 205 Hz

(3) 190 Hz

(4) 210 Hz

5. **In open organ pipe of length ℓ if the velocity of sound is v then the fundamental frequency will be**

(1) $\frac{v}{2\ell}$ and all harmonic are present

(2) $\frac{v}{4\ell}$ and all harmonic are present

(3) $\frac{v}{2\ell}$ and all harmonic are absent

(4) $\frac{v}{4\ell}$ and all harmonic are absent

Answer Key

Question	1	2	3	4	5
Answer	3	1	3	2	1

SOLUTIONS

1. **(3)**

$\lambda_1 = 2\ell \qquad \lambda_2 = 2(\ell + \Delta\ell)$

$n_1 = \frac{v}{2\ell}$ and $\quad n_2 = \frac{v}{2(\ell+\Delta\ell)}$

Number of beats

$n_1 - n_2 = \frac{v}{2}\left(\frac{1}{\ell} - \frac{1}{\ell+\Delta\ell}\right)$

$\boxed{n_1 - n_2 = \left(\frac{v\Delta\ell}{2\ell^2}\right)}$

2. **(1)**

Fundamental frequency $n = \frac{v}{2\ell}$

$350 = \frac{350}{2\ell}$

$\ell = \frac{1}{2}m = 50cm$

3. **(3)**

3^{rd} harmonic i.e. second overtone

So, if m^{th} overtone, then number of nodes = m + 1 = 2 + 1 = 3

4. **(2)**

Let the fundamental frequency of organ pipe be, f

Case -1

$f = 200 \pm 5 \Rightarrow 205Hz or 195Hz.$

Case - 2

Frequency of 2^{nd} harmonic of organ pipe = 2f.

2f = 420 $\pm$ 10

f = 210 $\pm$ 5 or

f = 205 Hz or 215 Hz

Hence the fundamental frequency of organ pipe = 205 Hz.

5. **(1)**

For first mode of vibration in an open organ pipe of length ℓ

$\frac{\lambda_1}{2} = \ell \Rightarrow \lambda_1 = 2\ell$ So, $n_1 = \frac{v}{\lambda_1} = \frac{v}{2\ell}$

This is called fundamental frequency of open organ pipe or first harmonic.

Now, for second mode of vibration in an open organ pipe

$\lambda_2 = \ell$, So, $n_2 = \frac{v}{\lambda_2} = \frac{v}{\ell} = 2n_1$,

This is called second harmonic as its frequency is twice of the fundamental frequency.

For third mode of vibration in an open organ pipe,

$\frac{3\lambda_3}{2} = \ell \Rightarrow \lambda_3 = \frac{2\ell}{3}$, So, $n_3 = \frac{v}{\lambda_3} = \frac{v}{\frac{2\ell}{3}} = 3n_1$

This is called third harmonic as its frequency is thrice of fundamental frequency. Therefore, all harmonic (odd and even) are present in an open pipe.

Resonance Tube DPP-12

1. In a resonance tube, using a tuning fork of frequency 325 Hz, two successive resonance length are observed as 25.4 cm and 77.4 cm respectively. The velocity of sound in air is

(1) $338\ \mathrm{ms}^{-1}$
(2) $328\ \mathrm{ms}^{-1}$
(3) $330\ \mathrm{ms}^{-1}$
(4) $320\ \mathrm{ms}^{-1}$

2. A long glass tube is held vertically in water. A tuning fork is struck and held over the tube. Strong resonances are observed at two successive lengths 0.50 m and 0.84 m above the surface of water. If velocity of sound is $340\ \mathrm{ms}^{-1}$, then the frequency of the tuning fork is

(1) 128 Hz
(2) 256 Hz
(3) 384 Hz
(4) 500 Hz

3. In the experiment for the determination of the speed of sound in air using the resonance column. The column resonates in the fundamental mode, with a tuning fork and length of air column is 0.1m length. When this length is changed to 0.35m, the same tuning fork resonates with the first overtone. Calculate the end correction.

(1) 0.012 m
(2) 0.025 m
(3) 0.05 m
(4) 0.04 m

4. In a resonance tube the first resonance with a tuning fork occurs at 16 cm and second at 49 cm. If the velocity of sound is 330 m/s, the frequency of tuning fork is

(1) 500 Hz
(2) 300 Hz
(3) 330 Hz
(4) 165 Hz

5. The end correction of resonance tube is 1 cm. If lowest resonant length is 15 cm then next resonant length will be –

(1) 36 cm
(2) 45 cm
(3) 46 cm
(4) 47 cm

Answer Key

Question	1	2	3	4	5
Answer	1	4	2	1	4

SOLUTIONS DPP-14

1. **(1)**

$v = 2f(\ell_2 - \ell_1)$

$= 2 \times 325(77.4 - 25.4)$ cm/sec

$= \frac{650\times52}{100} ms^{-1}$

$= 338$ m/sec

2. **(4)**

From $v = 2f(\ell_2 - \ell_1)$

$f = \frac{v}{2(\ell_2-\ell_1)} = \frac{340}{2(0.84-0.50)}$

$= \frac{340}{2\times0.34} =$ 500 Hz

3. **(2)**

Let $\Delta\ell$ be the end correction. Given that,
Fundamental tone for a length 0.1m = first overtone for the length 0.35m

$\frac{v}{4(0.1+\Delta\ell)} = \frac{3v}{4(0.35+\Delta\ell)}$

Solving this equation, we get $\Delta\ell = 0.025$ m

4. **(1)**

For closed pipe,

$v = 2f(\ell_2 - \ell_1)$

$\Rightarrow f = \frac{v}{2(\ell_2-\ell_1)}$

$f = \frac{330}{2\times(0.49-0.16)} =$ 500 Hz

5. **(4)**

e = 1

$e = \frac{\ell_2-3\ell_1}{2}$

$1 = \frac{\ell_2-3\times15}{2}$

$2 = \ell_2 - 45$

$\ell_2 = 47$cm

Doppler's Effect of Sound DPP-13

1. Doppler effect is applicable for

(1) moving bodies
(2) one is moving and other are stationary
(3) for relative motion
(4) none of these

2. With what velocity an observer should move relative to a stationary source so that he hears a sound of double the frequency of source

(1) Velocity of sound towards the source
(2) Velocity of sound away from the source
(3) Half the velocity of sound towards the source
(4) Double the velocity of sound towards the source

3. A train moves towards a stationary observer with speed 34 m/s. The train sounds a whistle and its frequency registered by the observer is f_1. If the train's speed is reduced to 17 m/s the frequency registered is f_2. If the speed of sound is 340 m/s then the ratio $\frac{f_1}{f_2}$ is

(1) 2
(2) $\frac{1}{2}$
(3) $\frac{18}{19}$
(4) $\frac{19}{18}$

4. Doppler effect is independent of

(1) distance between source and listener
(2) velocity of source
(3) velocity of listener
(4) none of the above

5. The source producing sound and an observer both are moving along the direction of propagation of sound waves. If the respective velocities of sound, source and an observer are v, v_s, and v_0 then the apparent frequency heard by the observer will be (n = frequency of sound)

(1) $\frac{n(v+v_0)}{v-v_0}$
(2) $\frac{n(v-v_0)}{v-v_s}$
(3) $\frac{n(v-v_0)}{v+v_s}$
(4) $\frac{n(v+v_0)}{v+v_s}$

6. **A sound source is moving towards stationary listener with $\frac{1}{10}$th of the speed of sound. The ratio of apparent to real frequency is**

(1) $\frac{9}{10}$

(2) $\frac{10}{9}$

(3) $\frac{11}{10}$

(4) $\frac{10}{11}$

7. **A police car horn emits a sound at a frequency 240 Hz when the car is at rest. If the speed of sound is 330 m/s, the frequency heard by an observer who is approaching the car at speed of 11 m/s.**

(1) 248 Hz

(2) 244 Hz

(3) 240 Hz

(4) 230 Hz

8. **A source emits a sound of frequency of 400 Hz, but the listener observes 390 Hz. Then**

(1) The listener is moving towards the source

(2) The source is moving towards the listener

(3) The listener is moving away from the source

(4) The listener has defective ear

9. **An observer is moving towards the stationary source of sound, then**

(1) Apparent frequency will be less than the real frequency

(2) Apparent frequency will be greater than the real frequency

(3) Apparent frequency will be equal to real frequency

(4) Only the quality of sound will charge

10. **An engine is moving on a circular path of radius 100 m with speed of 20 m/sec. It is blowing a whistle of frequency 500 Hz. The frequency observed by an observer standing stationary at the centre of the circular path is**

(1) equal to actual frequency

(2) more than actual frequency

(3) less than actual frequency

(4) more or less than depending on the actual speed of the engine

11. **The frequency of a whistle of an engine is 600 cycles/sec and it is moving with the speed of 30 m/sec towards an observer. The apparent frequency will be (velocity of sound = 330 m/s)**

(1) 600 cps
(2) 660 cps
(3) 990 cps
(4) 330 cps

12. **An observer moves towards a stationary source of sound of frequency n. The apparent frequency heard by him is 2n. If the velocity of sound in air is 332 m/sec, then the velocity of the observer is**

(1) 166 m/sec
(2) 664 m/sec
(3) 332 m/sec
(4) 1328 m/sec

13. **Two passenger trains moving with a speed of 108 km/hour cross each other. One of them blows a whistle whose frequency is 750 Hz. If sound speed is 330 m/s, then passengers sitting in the other train, after trains cross each other will hear sound whose frequency will be**

(1) 900 Hz
(2) 625 Hz
(3) 750 Hz
(4) 800 Hz

14. **A source of sound emitting a note of frequency 200 Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is**

(1) 50 Hz
(2) 200 Hz
(3) 150 Hz
(4) 100 Hz

15. **Doppler's effect will not be applicable when the velocity of sound source is**

(1) Equal to that of the sound velocity
(2) Less than the velocity of sound
(3) Greater than the velocity of sound
(4) Zero

16. A source of sound is travelling with a velocity 40 km/hour towards observer and emits sound of frequency 2000 Hz. If velocity of sound is 1220 km/hour, then what is the apparent frequency heard by an observer

(1) 2210 Hz

(2) 1920 Hz

(3) 2068 Hz

(4) 2086 Hz

17. A siren emitting sound of frequency 500 Hz is going away from a static listener with a speed of 50 m/sec. The frequency of sound to be heard, directly from the siren, is (velocity of sound = 330 m/sec)

(1) 434.2 Hz

(2) 589.3 Hz

(3) 481.2 Hz

(4) 286.5 Hz

18. A car sounding a horn of frequency 1000 Hz passes an observer. The ratio of frequencies of the horn noted by the observer before and after passing of the car is 11 : 9. If the speed of sound is v, the speed of the car is

(1) $\frac{1}{10}v$

(2) $\frac{1}{2}v$

(3) $\frac{1}{5}v$

(4) v

19. A source and an observer approach each other with same velocity 50 m/s. If the apparent frequency is 435 Hz, then the real frequency is

(1) 322 Hz

(2) 360 Hz

(3) 390 Hz

(4) 420 Hz

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	3	1	4	1	2	1	3	2	2	1	2	3	2	4	3
Question	16	17	18	19											
Answer	3	1	1	1											

SOLUTIONS DPP-15

1. **(3)**

The doppler effect occurs not only for sound. But for any wave when there is relative motion between the observer and the source.

2. **(1)**

By using

$n' = n\left(\frac{v-v_0}{v}\right)$

$2n = n\left(\frac{v-v_0}{v}\right)$

$2v = v - v_0$

$v_0 = -v = -$ (speed of sound)

Negative sign indicates that observer is moving opposite to the direction of velocity of sound.

3. **(4)**

$f_{app} = f_0\left(\frac{v \pm v_0}{v \pm v_s}\right)$

$f_1 = f_0\left(\frac{340}{340-34}\right) = f_0\left(\frac{340}{306}\right)$

$f_2 = f_0\left(\frac{340}{340-17}\right) = f_0\left(\frac{340}{323}\right)$

$\frac{f_1}{f_2} = \frac{323}{306} \Rightarrow \frac{f_1}{f_2} = \frac{19}{18}$

4. **(1)**

Doppler effect independent of distance between source and observer.

5. **(2)**

As bot observer and source are moving in the direction of sound, so the velocities are for sign convention are positive. So, the apparent frequency is given by

$n' = n\left(\frac{v-v_0}{v-v_s}\right)$

6. **(2)**

Let the speed of sound in air be v i.e. $v_{sound} = v$

Thus, the velocity of source, $v_{source} = \frac{v}{10}$.

Let n and n′ be the real frequency of the source & apparent frequency heard by the observer, respectively. Using doppler effect when the source is moving towards the stationary observer:

$n' = n\left[\frac{v_{sound}}{v_{sound} - v_{source}}\right]$

$n' = n\left[\frac{v}{v - \frac{v}{10}}\right] = \frac{10}{9}$

$\frac{n'}{n} = \frac{10}{9}$

7. **(1)**

Given $v = 330\,m/s,\ v_0 = 11\,m/s,\ n = 240\,Hz$

Frequency heard by the observer

$n' = n\left(\frac{v+v_0}{v}\right)$

$= 240\left(\frac{330+11}{330}\right) = 248$ Hz

8. **(3)**

Since apparent frequency is lesser than the actual frequency, hence the relative separation between source and listener should be increasing.

9. **(2)**

Apparent frequency will be greater than the real frequency. So apparent frequency in this case,

$n' = n\left(\frac{v+v_0}{v}\right)$

$\frac{v+v_0}{v} > 1 \Rightarrow \frac{n'}{n} > 1$

$\text{i.e.}\ n' > n$

10. **(1)**

Here relative motion of engine is perpendicular to the observer so, there is no doppler effect so the frequency of whistle reaching the observer will remain same. so observed frequency is 500 Hz.

11. **(2)**

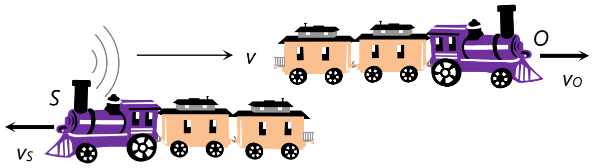
$n' = n\left(\frac{v}{v - v_S}\right) = 600\left(\frac{330}{300}\right) = 660\text{cps}$

12. **(3)**

$n' = n\left(\frac{v+v_O}{v}\right) \Rightarrow 2n = n\left(\frac{v+v_0}{v}\right) \Rightarrow \frac{v+v_0}{v} = 2$

$\Rightarrow v_O = v = 332$m/sec

13. **(2)**



$$n' = n\left(\frac{v - v_O}{v + v_S}\right) = 750\left(\frac{330 - 108 \times \frac{5}{18}}{330 + 108 \times \frac{5}{18}}\right) = 625\text{ Hz}$$

14. **(4)**

Since there is no relative motion between observer and source, therefore there is no apparent change in frequency.

15. **(3)**

16. **(3)**

$$n' = n\left(\frac{v}{v - v_S}\right) = \frac{2000 \times 1220}{(1220 - 40)} = 2068\text{ Hz}$$

17. **(1)**

$$n' = n\left(\frac{v}{v + v_S}\right) = 500 \times \left(\frac{330}{330 + 50}\right) = 434.2\text{Hz}$$

18. **(1)**

$n_{Before} = \left(\frac{v}{v - v_c}\right) n$ and $n_{After} = \left(\frac{v}{v + v_c}\right) n$

$\frac{n_{Before}}{n_{After}} = \frac{11}{9} = \left(\frac{v + v_c}{v - v_c}\right) \Rightarrow v_c = \frac{v}{10}$

Stationary observer

19. **(1)**

$n' = n\left[\frac{v + v_O}{v - v_S}\right]$; Here $v = 332$ m/s and $v_0 = v_s = 50$m/s

$$\Rightarrow 435 = n\left[\frac{332 + 50}{332 - 50}\right] \Rightarrow n = 321.27\text{Hz} \simeq 322\text{Hz}$$

Doppler's Effect of Light DPP-14

1. A star is continuously moving away from us then the wavelength coming from star on the earth:
(1) Will shift towards violet colour
(2) Will shift towards red colour
(3) Remain unchanged
(4) Will shift sometimes towards violet and some other time it will shift towards red colour.

2. The term "Red shift" referring to doppler's effect for light represent which of following property:
(1) Decrease in frequency
(2) Increase in frequency
(3) Decrease in intensity
(4) Increase in intensity

3. Doppler effect for light differs form that for sound in regards that:
(1) The relative frequency shift is smaller for light than for sound
(2) Velocity of light is independent of frame
(3) Velocity of light is very large as compared to sound
(4) Light waves are electromagnetic waves but sound waves are mechanical

4. In astronomy, increase in wavelength due to doppler effect is known as:
(1) Red shift
(2) Violet shift
(3) UV shift
(4) IR shift

5. An astronomical object is moving with such a speed that red shift of 1 nm is observed in wavelength 600 nm of wave received from it, the speed of wave is:
(1) 5×10^5 m/s
(2) 4×10^5 m/s
(3) 3×10^5 m/s
(4) 2×10^5 m/s

6. If a star emitting light of wavelength $6000\ \text{Å}$ is moving away from earth with a velocity of 2×10^6 m/s then find the shift in the wavelength due to Doppler's effect?
(1) 20 Å
(2) 30 Å
(3) 40 Å
(4) 50 Å

Answer Key

Question	1	2	3	4	5	6
Answer	2	1	2	1	1	3

SOLUTIONS

1. **(2)**

2. **(1)**

Red shift means increase in wavelength i.e. decrease in frequency.

3. **(2)**

4. **(1)**

Red shift means increase in wavelength and violet shift means decrease in wavelength.

5. **(1)**

$\Delta\lambda = \lambda_0 \frac{v}{c} \Rightarrow 1\ \text{nm} = 600\ \text{nm}\frac{v}{c}$

$\Rightarrow v = 5 \times 10^5\ \text{m/s}$

6. **(3)**

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

$$\Delta\lambda = \frac{v}{c} \times \lambda$$

$$\Delta\lambda = \frac{2 \times 10^6}{3 \times 10^8} \times 6 \times 10^{-7}$$

$$\Delta\lambda = 40\ \text{Å}$$